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Abstract

Many environmental problems have occurred because the current generation affects future generations, but the opposite is not true. This one-way nature induces the current generation to take advantage of resources without considering future generations, which we call "intergenerational sustainability dilemma (ISD)." While deliberation is known to bring a change in individual opinions and lead to a better decision in some intragenerational problems, little is known about how "intragenerational deliberation" affects individual opinions and collective decisions for "intergenerational problems such as ISD" in societies. To this end, an ISD game (ISDG) along with interviews and questionnaires are instituted in rural and urban areas of Nepalese societies. In ISDG, a sequence of six generations, each of which consists of three people, is organized, and each generation chooses either to maintain intergenerational sustainability (sustainable option) or to maximize her own generation's payoff by irreversibly imposing a cost on future generations (unsustainable option) under intragenerational "deliberative" process. Our result demonstrates that urban subjects have a wider variety of individual initial opinions and support an unsustainable option more often than do rural subjects. It also shows that individual opinions change through deliberation when subjects in a generation do not share the same initial opinion, reflecting that more urban subjects change opinions; such opinion changes are identified not to work in the direction to enhance intergenerational sustainability for the urban generations. Overall, our experiment suggests that a closely-knit society such as rural areas in Nepal is a hope, and intragenerational deliberation neither effectively affect individual opinions for intergeneration sustainability nor resolve ISD.

Key Words: Intergenerational sustainability dilemma; deliberative process; opinion change

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Nomenclature

IFG Imaginary future generation

ISD Intergenerational sustainability dilemma

ISDG Intergenerational sustainability dilemma game

NPR Napalese rupee

SVO Social value orientation

VDC Village development committee

1 Introduction

What the current generation does affects future generations, but the opposite is not true. This one-way nature induces the current generation to take advantage of resources without fully considering future generations, which we call the "intergenerational sustainability dilemma (ISD)," and it is claimed to be a cause of many important problems (Kamijo et al., 2017, Shahrier et al., 2017, Nakagawa et al., 2019). Intergenerational problems have occurred, such as climate change, resource depletion, biodiversity loss and long-term governmental debts. However, neither market nor democracy is known to be future-oriented, and it has been pointed out that these institutions favor the current generation maximizing her benefits (Pigou, 1952, Krutilla, 1967, Garri, 2010, Thompson, 2010). Intragenerational deliberation is known to bring changes in individual opinions and to lead to a better decision in some setting of intragenerational problems (Joseph, 1994, Ostrom, 1990, Ghate et al., 2013, Konrad and Thum, 2018). However, little is known about how "intragenerational deliberation" can be effective to affect individual opinions and collective decisions for solving "intergenerational problems" such as ISD in societies.

The fundamental nature of the sustainability problems can be characterized by ISD. Economic literature defines sustainability as a minimum condition to be satisfied, that is, maintaining the welfare of successive generations, as compared with the current generation (Dasgupta and Mitra, 1983, Howarth and Norgaard, 1993, Weitzman, 1997). However, many significant social problems have occurred because societies violate the minimum condition of sustainability in which the current generation prioritizes her benefit and leave more burdens on future generations. There is a severe threat of global climate change and outstanding governments' debts in some countries that takes more than 100 years to repay (Hansen and Imrohoroglu, 2016). The coastal communities are predicted to suffer from a sea-level rise of $2\,\mathrm{m}$ by 2100, and it is reported that the rise is due to high greenhouse gas emission the current generation cast, leaving huge burdens on many unseen future generations (Bamber et al., 2019). Such intergenerational problems can be well represented to occur among non-overlapping generations in a long-run perspective.[1] Therefore, this paper addresses

[1] Schotter and Sopher (2003, 2006, 2007), Chaudhuri and Paichayontvijit (2006) and Chaudhuri et al. (2009) use

the ISD problem under non-overlapping generations by conducting framed field experiments.

Over the last decade, several studies have used an experimental approach to examine people's preferences and behaviors regarding intergenerational sustainability. Fisher et al. (2004) show that people become less motivated to exploit resources owing to the existence of an "intergenerational link" in an intergenerational common pool experiment. Hauser et al. (2014) demonstrate that democracy or majority voting tends to promote sustainability of intergenerational goods when a majority of people are prosocial. Sherstyuk et al. (2016) analyze the level of difficulties in maintaining dynamic externality by implementing laboratory experiments of a dynamic game under two types of settings: (i) infinitely living decision makers and (ii) multiple generations. They find that strategic uncertainty makes it difficult to retain dynamic externalities. Kamijo et al. (2017) design and implement a laboratory experiment of ISD game (ISDG) with a subject pool of university students by introducing the treatment of "imaginary future generation (IFG)" as negotiators for future generations, claiming that the negotiators improve intergenerational sustainability. Shahrier et al. (2017) conduct ISDG field experiments with the subject pool of general people and analyze generation decisions in urban and rural areas of Bangladesh. They find that rural people are more prosocial and choose a sustainable option more often than urban people.[2] Fochmann et al. (2018) find that subjects are prudent and fair for an intrageneration allocation, but show fewer concerns for intergenerational fairness in a laboratory experiment. They also claim that the current generation maximizes her payoff through shifting the burden of debts to future generations.

Many political scientists and psychologists have studied deliberation to understand processes of collective decisions making (Rawls, 1993, Chambers, 2003, Niemeyer and Dryzek, 2007).[3] Several

experimental games in which the current generation is incentivized to give advice to subsequent generations for their better choices and the possibility of Pareto improvement mostly exists. More specifically, the current generation's payoff depends on subsequent generations' actions (or performances) as if the relation is between parents and children. Schotter and Sopher (2003, 2006, 2007), Chaudhuri and Paichayontvijit (2006) and Chaudhuri et al. (2009) refer this type of overlapping generational situations to as "intergenerational setting," and address the roles of social learning through advice over generations. However, in ISD, our focus is on addressing sustainability for long-run relationship across generations as if they are non-overlapping, and such long-run sustainability problems are exemplified by emergence of global climate change, various environmental problems and government debts as mentioned earlier.

[2]Shahrier et al. (2017) also seek to confirm whether or not the IFG proposed by Kamijo et al. (2017) enhances intergenerational sustainability, demonstrating that the IFG is not effective.

[3]The popular decision-making mechanisms by groups in experiments are majority voting and unanimity (See, e.g., Denant-Boomont et al., 2017). An exception is Gerardi and Yariv (2007) that implement a "deliberative majority

experimental studies, such as Simon and Sulkin (2002), have analyzed the role of deliberation in relation to equity and sociodemographic backgrounds, concluding that deliberative discussion can bring about fair and equitable outcomes for intragroup members. Goeree and Yariv (2011) also conduct deliberation experiments under different institutions of majority and unanimity, reporting that deliberation promotes fair outcomes across the institutions. Ban et al. (2012) use field data from south India, suggesting that, even in heterogeneous societies, deliberation is important in that it can induce long-term agreement about priorities of providing several public goods. List et al. (2013) analyze deliberative data, showing that deliberation can help resolve the salient issues. Overall, theories and empirical studies suggest that deliberation is effective in many collective decision environments.

Group behaviors have been intensively studied to understand how communication influences people's behaviors through social interactions (Dawes et al., 1977, Isaac and Walker, 1988, Bornstein and Ben-Yossef, 1994, Kugler et al., 2012, Charness and Sutter, 2012, Cooper and Kuhn, 2016, Meub and Proeger, 2017, Crawford and Harris, 2018, Carbone et al., 2019, Vollstadt and Bohm, 2019). Intragroup communication makes groups more competitive and self-regarding in a socioeconomic context such as market competition, tournament and bargaining (Kugler et al., 2012, Charness and Sutter, 2012). Cason and Mui (1997) use a dictator game allowing for intragroup face-to-face communication in a non-competitive and non-strategic environment, and claim that such communication induces intergroup fairness. On the other hand, Luhan et al. (2009) conduct a dictator game to re-examine group behaviors by letting subjects to make not only individual but also group decisions using electronic chats as a medium of communication. They find that groups are more selfish than individuals, and the most selfish group member has the strongest influence on group decisions.[4] Overall, how intragroup (intrageneration) face-to-face communication (deliberation) affects intergroup (intergenerational) fairness in economic decision-making is

voting" rule to understand coordination in a group decision. They identify that it eliminates some possible outcomes and does not necessarily lead to a better decision.

[4]Numerous experimental studies have used simple distribution games or dictator games to confirm an existence of people's concerns toward others, such as altruism, empathy and fairness, finding that people do not selfishly behave by giving a substantial share to others in such games (Fehr, 1999, Fehr and Gachter, 2000, Fischbacher et al., 2001, Charness and Rabin, 2002, Engelmann and Strobel, 2004).

an important area to be explored and analyzed.[5]

Irrespective of types of governance, institutions and societies, whether people care about others or future generations depends on the degrees of prosociality, trust and fairness, which are affected by the cultural and economic environment (Ockenfels and Weimann, 1999, Henrich et al., 2005, Wilson et al., 2009, Henrich et al., 2010a, Brosig-Koch et al., 2011, Leibbrandt et al., 2013, Shahrier et al., 2017). Furthermore, as societies become more capitalistic and competitive, the current generation tends to become more proself, compromising sustainability (Fisher et al., 2004, Shahrier et al., 2016, 2017, Timilsina et al., 2017). Although social devices such as communication, discussion and deliberation in collective decision-making are demonstrated to resolve some class of intragenerational problems on not only social but also economic issues, such as prisoner's dilemma, public goods provision and common pool resource utilization (Cardenas, 2000, Cardenas et al., 2000, Cason et al., 2012, Ghate et al., 2013), little is known about how "intragenerational deliberation" affects individual opinions and collective decisions for "intergenerational problems" such as ISD in societies.

We design and institute a series of new procedures for the ISDG field experiments to examine whether and how deliberation changes individual opinions and hence resolves ISD in fields. In ISDG, we organize a sequence of six generations, each of which consists of three subjects, and each generation is asked to decide between maintaining intergenerational sustainability (sustainable option) and maximizing its own generation's payoff by irreversibly imposing a cost on future generations (unsustainable option) through deliberative discussion. As a new element of our ISDG experimental design, we conduct individual interviews after subjects finish making their generation's decision. In the interviews, we elicit each subject's "individual initial opinion" about which option she supported before and "individual final opinion" after her generation's deliberation as a personal opinion, respectively. This interview process enables us to clarify whether each subject

[5] An important area of investigation in economics is how intragroup interactions affect intergroup economic outcomes to resolve some dilemmas and it has a long-term impact (Hauge et al., 2019, Brandon et al., 2019, Kotchen and Segerson, 2019, Tilman et al., 2019). The past literature has shown that social interactions influence group choices. Building upon these studies, our ISDG experiments are designed for the purpose of understanding and exploring how intragroup (intragenerational) face-to-face communication can be effective for intergroup (intergenerational) fairness as discussed in Engelmann and Strobel (2004).

changes her opinions over a course of deliberation. To generalize and better characterize the role of deliberation on ISD in real fields, we conduct our experiment along with a questionnaire survey for sociodemographic and psychological information in both rural and urban areas of Nepal.[6] With this approach, this paper seeks to answer the following open questions: (i) Does intragenerational deliberation change individual opinions of rural and urban subjects for an intergenerational problem such as ISD in a different manner? (ii) Do such changes in individual opinions induce generations to resolve ISD in each society?

2 Methods and materials

2.1 Study areas

We conduct the experiments in two kinds of Nepalese fields: (i) urban areas, such as Kathmandu, Lalitpur, Bhaktapur and Pokhara city, and (ii) rural areas of several traditional villages from Prabhat and Chitwan districts. Both areas are almost homogeneous in terms of culture, language and religion. The urban areas usually have the highest human development index (HDI) on the basis of UNDP (2014), and the population density is high. For instance, Kathmandu has a population density of 4416 people per km^2 (Central Bureau of Statistics, 2011) and is the most crowded city, with $24.3\,\%$ of the total urban population in Nepal. Big cities such as Kathmandu and Pokhara are the centers for businesses and services. The rural areas consist of different villages of the Western Hills and Central Terai, such as the Prabhat and Chitwan districts (figure 1). The population densities of Chitwan and Prabhat are 261 people per km^2 and 297 people per km^2, respectively (Central Bureau of Statistics, 2011). All of these villages are agrarian societies, and the dwellers engage in farming generation after generation. A limited number of businesses and services, typically small-scale ones, are available.

[6] Henrich et al. (2001) and Fehr and Leibbrandt (2011) demonstrate that observations of any economic decision in experiments tend to reflect naturally occurring situations or vice versa. In this sense, this experimental framework in rural and urban areas can be considered a useful building block to understand and clarify whether there are differences across people's opinions regarding ISD in various societies.

[Figure 1 about here.]

2.2 Experimental setup

We conduct an intergenerational sustainability dilemma game (ISDG), an individual interview, a social value orientation (SVO) game and questionnaire surveys to obtain critical thinking disposition and sociodemographic data in the field.

Intergenerational sustainability dilemma game and deliberation

The ISDG is implemented following the laboratory and field experiments in Kamijo et al. (2017) and Shahrier et al. (2017). Building upon these previous ISDG experiments, we add a new element of individual interviews to the experimental design, the details of which shall be discussed later. Three subjects in a group are called a generation, and each generation needs to choose between options A and B. The generation receives a payoff of X by choosing option A and the payoff $X - 300$ by choosing option B. After making a choice between options A and B, the generation is asked to split the payoff associated with the option they choose among the generation members. Each of the subject's payoffs in ISDG is the sum of their generation share plus the initial experimental endowment of 300. For instance, by choosing A, the generation earns 1200 experimental points ($X = 1200$), whereas by choosing B, the generation earns 900 points ($= X - 300 = 1200 - 300$). Consequently, if members of this generation split the payoff equally among them, each member earns 400 by choosing A and 300 by choosing B as a generation share. Therefore, the total payoff of each subject with generation choice A becomes 700 ($= 400 + 300$), whereas it becomes 600 ($= 300 + 300$) with generation choice B.

Each generation is allowed to deliberate over the decision between options A and B as well as how to split the generation payoff up to 10 minutes of discussion. However, when the decisions cannot be made within 10 minutes, the following rules have been applied, (1) if the generation share the group receives is positive, each member receives an initial endowment of 300 only, (2) if the

generation share the group receives is negative, say, $-Z$, each member equally splits $-Z$ by three and receives the payment of $-Z/3$ plus an initial endowment of 300 (See a supplementary material of experimental instructions for the details). After the generation decision between A and B, each subject undergoes an individual interview in which she is asked to state her "individual initial opinion" and "individual final opinion" regarding supporting A or B. This individual interview is a new element compared to the preexisting ISDG experiments in Kamijo et al. (2017) and Shahrier et al. (2017), clarifying how an individual opinion changes over a course of deliberation and the role of deliberation for affecting individual opinions.

Each session consists of $18 \sim 24$ subjects, organizing a sequence of $6 \sim 8$ generations. Each generation is randomly assigned to one of the 1st, 2nd, ... and 6th generations. When the number of subjects that participated in a session are 21 or 24, we organize 7th and even 8th generations. However, they are assigned as 1st and 2nd in another sequence of generations as indicated in figure 3. One generation's decision affects the subsequent generations such that subsequent generations' payoffs decreases uniformly by 300 when the current generation chooses option A, otherwise not. For instance, suppose that $X = 1200$ and the 1st generation chooses A. Then, the 2nd generation will face a game in which they can receive 900 and 600 by choosing A and B, respectively. However, if the 1st generation chooses B, the next generation can have the same decision environment as the 1st generation faced. That is, when the 1st generation chooses B, the 2nd generation can have the game in which they can receive 1200 and 900 by choosing A and B, respectively. Following the same rule, the game continues for the rest of the subsequent two generations (i.e., between ith and $i+1$th generations). Hence, option B can be considered a "sustainable option," whereas option A is the choice that compromises intergenerational sustainability and can be considered as an "unsustainable option." In each session, the 1st generation starts ISDG with $X = 1200$, implying that the 5th and 6th generations may face the game in which options A and B are associated with payoffs of zero and -300, respectively, when previous generations keep choosing option A.[7] In ISDG, the subjects are paid $550\,\mathrm{NPR}$ ($\approx 5.50\,\mathrm{USD}$) at maximum and

[7]When the 5th and 6th generations face the game in which options A and B are associated with zero or a negative payoff of -300, the generation members can refund themselves equally from their initial endowment of 300 to make

$350\,\mathrm{NPR}$ ($\approx 3.50\,\mathrm{USD}$) on average (The NPR stands for Nepalese rupees).

Individual interviews

An individual interview is conducted for each subject after her generation decides between options A and B in ISDG. In this interview, we investigate the patterns of the shift in individual opinions to have supported A, B or to have been ambivalent (no ideas) coded as N as her "individual initial opinion" and "individual final opinion" before and after the deliberation, respectively. Each subject is asked to answer whether she supported A, B or N and the associated reasons "before and after" a course of deliberation. The interviewers ask questions such as (1) "your personal opinion might have been different from the group decision. At the moment of the group decision, what did you really want to support as your personal opinion?" for her "individual final opinion" and the corresponding reasons and (2) "Before the group deliberation started, what did you really support as your personal opinion?" for her "individual initial opinion" and the corresponding reasons.

The individual interviews successfully identify whether each subject changes her individual opinion to have supported A, B and/or N through deliberation. For instance, some subject is recognized to have supported A as her "individual initial opinion" before deliberation but to have ended up supporting B as her "individual final opinion" after deliberation. In this case, her opinion change is coded as AB, where the first letter represents her initial personal support for A before deliberation and the second letter does her final personal support for B after deliberation. In the same manner, we identify and code subjects' opinion changes through individual interviews, and the possible combinations of opinion changes are $AA, AB, AN, BA, BB, BN, NA, NB$ and NN. With this information about individual opinion changes before and after deliberation, we can also identify whether each generation has a unanimous opinion agreement to decide between options A and B before and after deliberation.[8]

the individual payoff be at least zero.

[8] An alternative way to collect the same data of individual opinions is to incentivize or to ask each subject to reveal their opinions to support A, B and N in a timely manner, i.e., each subject is asked to reveal an "individual initial opinion" before deliberation and again asked to reveal an "individual final opinion" after deliberation. However,

Social value orientation (SVO) games

An SVO experiment of the "slider method" is conducted to identify subjects' social preferences as prosocial or proself in urban and rural areas, following Murphy et al. (2011). Figure 2 shows six items of the slider measure that assign numbers to represent outcomes for oneself and for the other in a pair of persons, where the other is unknown to the subject. Subjects are asked to make one choice among the nine options for each item. Each subject chooses her allocation by marking a line at the point that defines her most preferred distribution between oneself and the other (See figure 2). The mean allocation for oneself $\overline{A}_s$ and the mean allocation for the other $\overline{A}_o$ are computed from all six items (See figure 2). Then, 50 is subtracted from $\overline{A}_s$ and $\overline{A}_o$ to shift the base of the resulting angle to the center of the circle $(50, 50)$. The index of a subject's SVO is given by SVO $= \arctan \frac{(\overline{A}_o)-50}{(\overline{A}_s)-50}$. Depending on the values generated from the test, social preferences are categorized as follows: 1. altruist: SVO $> 57.15°$, 2. prosocial: $22.45° <$ SVO $< 57.15°$, 3. individualist: $-12.04° <$ SVO $< 22.45°$ and 4. competitive: SVO $< -12.04°$.

[Figure 2 about here.]

The SVO framework assumes that people have different motivations and goals for evaluating resource allocations between oneself and others. Also, the SVOs or social preferences are established to be stable for a long time (See, e.g., Van Lange et al., 2007, Brosig-Koch et al., 2011). Responses that are yielded from six primary items give complete categories of social preferences. Major reasons for using six primary slider measures developed by Murphy et al. (2011) are its simplicity and it is easy to implement in the Nepalese context. It is intuitive for subjects to understand

this timely-manner procedure does not reflect the process of real-world deliberative group decisions, and it is also reported to induce subjects to have unnecessarily strong priming and anchoring effects on individual opinions that influence group deliberations and decisions (Kahneman, 2011, Kotani et al., 2014). Qualitative behavioral research establishes that individual opinions and ideas can be truthfully elicited by individual interviews after the incidences of interest (Brinkmann, 2014). In addition, in our pilot experiment with 48 subjects, we confirm that individual initial and final opinions elicited by our interview procedure are consistent with group deliberations and decisions. Subjects might show active misrepresentation of intentions in experiments when there is a strategic interaction to gain extra benefits (Crawford, 2003, Crawford and Harris, 2018). Following this line of research, we have used an interview method and this interview was conducted after the intragenerational deliberation where subjects have no intentions to lie. Specifically, we collect individual opinions through individual interviews "after" generations' decisions between options A and B are made. The main results in our research regarding individual opinions and generation decisions that will be presented later are consistent with one another.

even with a limited level of education. As is often done in psychology, we further simplify the four categories of social preferences into two categories of prosocial and proself types: "altruist" and "prosocial" types are categorized as "prosocial" subjects, whereas "individualistic" and "competitive" types are categorized as "proself" subjects (See Murphy et al., 2011). Subjects are informed that the units represented in this game are points and that more points mean he/she will earn more real money (See the SVO instruction in figure 2).

In this game, the subject receives $150\,\mathrm{NPR}$ (NPR = Nepalese rupees) after applying some exchange rate to the points she obtains ($\approx 1.5\,\mathrm{USD}$) at maximum and $100\,\mathrm{NPR}$ ($\approx 1.0\,\mathrm{USD}$) on average. Subjects are instructed not to talk or discuss and the decision for SVO is made in private. To compute the payoff of the subjects from this game, we collect the answer sheets from all subjects, then we randomly match one subject with another subject as a pair. The experimental payoff in this SVO game is the summation of points from 6 selections by herself for oneself and 6 selection by the partner for the other. We also explain the methods of random matching and payoff calculation with the exchange rate for the real money incentive to subjects.

Critical thinking disposition

Critical thinking is defined as a cognitive process that consist of many different skills such as analysis, evaluation, inference, and inquisitiveness that is used appropriately for making a logical solution to a problem or a valid conclusion to an argument (Dwyer and Hogan, 2014). The logical thinking subscale of the critical thinking disposition scale was adopted in the questionnaire surveys, following Nakagawa (2015). This subscale consists of 13 items, which could be translated into English as follows: (1) "I am good at thinking about complex problems in an orderly fashion," (2) "I am good at collecting my thoughts," (3) "I am confident in thinking about things precisely," (4) "I am good at making persuasive arguments," (5) "I am confused when thinking about complex problems" (reversed item), (6) "I am usually the one to make decisions because my peers believe I can make fair judgments," (7) "I can concentrate on grappling with problems," (8) "I can continue working on a difficult problem that is not straightforward," (9) "I can think about things coher-

ently," (10) "One of my shortcomings is that I am easily distracted" (reversed item), (11) "When I think about a solution, I am unable to think about other alternatives" (reversed item), (12) "I can inquire into things carefully," and (13) "I am constructive in proposing alternatives." Items were rated from 1 (strongly disagree) to 5 (strongly agree). The summation of rates from 1 to 5 over 13 items is the scale of critical thinking disposition, and the theoretical range is 13-65.

2.3 Experimental procedure

The experiments involve hiring local supporting staffs and research assistants (the first author is a chief administrator for the experiment). The experimental procedures are the same between urban and rural areas except for recruitment of subjects. In rural areas, subjects are informed in advance (a week ago) and asked to show up at the village schools and/or government agricultural community halls at a given date and time. To collect subjects, we are supported by local government offices known as village development committees (VDCs) and randomly select the households from the list of residents in rural areas (Central Bureau of Statistics, 2011). Based on the random selection, we send an invitation letter to the selected households and one member in a household is invited to participate in our experiments. The participation rate is approximately $95\,\%$ which becomes high due to proper incentives provided in this experiment.

In urban areas, we conduct occupation-based randomization by taking the desired number of subjects from each occupation such as banking, government, health, education, business, transportation and entertainment (Central Bureau of Statistics, 2011).[9] The experiment is conducted at district health organization training halls in urban areas that are in the center of the cities consisting of many rooms. We send an invitation letter to different offices requesting people to participate in our experiment. One week prior to the experiment, the letters are dispatched to the selected organizations. We conduct experiments on the weekend and, due to proper incentives, the participation rate is high that is $80\,\%$. On an average, we paid $550\,\mathrm{NPR}$ ($\approx 5.00\,\mathrm{USD}$) to each subject including a fixed participation fee of $100\,\mathrm{NPR}$ ($\approx 1.0\,\mathrm{USD}$) in rural and urban areas.

[9]Occupation-based randomization is done to have a representative urban sample in our experiments.

[Figure 3 about here.]

Upon arriving at the locations, subjects are gathered in one hall and they are given experimental instructions in their native language (Nepali). Once everybody is present in a room, an experimenter (the first author) also gives subjects a verbal explanation about experimental rules. To maintain anonymity across generations, first, we confirm that subjects have fully understood the rules, and second, they are asked to proceed toward a door one by one and pick up a chip out of a bag that contains their generation ID and individual ID.[10] According to the IDs, each subject goes to and sits in a specific room. In the end, we place the generations in separate rooms by their generation IDs. In this way, each subject can not observe and identify which person belong to a specific generation in a sequence (she knows only the members of her generation), however, they can realize that they are assigned to one generation within a sequence. However, they are not informed of which generation is the last within a sequence of generations.

The research assistants distribute questionnaires and explain the experimental procedures once again to subjects and keep them engage. In ISDG, the 1st generation makes deliberation up to 10 minutes where it is recorded and their generation decision is confirmed. Once a generation finishes making her decision after the deliberation, the members are asked to move to an individual interview room, one person by one person. This process is necessary to assure anonymity and privacy among subjects in a generations or across generations regarding how they answer in each interview. After the the 1st generation decision and individual interviews, we proceed to the 2nd generation with the same procedures. A series of these routines are applied to the rest of the next generations from 3rd to 6th ones.

The previous generations' decisions are passed to the subsequent generations and they can see them if they are other than the 1st generation.[11] Each subject in a generation is asked to confirm

[10]Several quizzes are administered to check subject's understanding of the game. We proceed with the experiment after confirming that all subjects answer the quizzes correctly.

[11]Note that we use more than 6 rooms in a session depending on the days, locations and the number of subjects, and prepare a separate room for each generation to keep anonymity among generation in a sequence (figure 3). This experimental environment is important to avoid a situation where the subjects have any "observer effect." In this way, we sought to avoid the "observer effect." On the other hand, some literature has concluded that the "observer effect" is mostly insignificant in many allocation games such as bargaining, dictator and ultimatum ones under laboratory

which generation they belong to in a sequence and the payoffs associated with options A and B. With this information, each generation deliberates and decides between intergenerational unsustainable option A and sustainable option B in an ascending order from the 1st generation to 6th generation. After the generation decision, each subject gets interviewed to state her "individual initial opinion" and "individual final opinion" to have supported A, B or N before and after deliberation. After the ISDG game and individual interviews, the SVO game follows. Finally, we ask subjects to finish questionnaire surveys for their sociodemographic and psychological information at the end of a session.

In ISD situations, there is no possibility of Pareto improvement across generations, all possible decisions are Pareto efficient, and rational agents & generations in standard economic theory are predicted to support and choose option A. In behavioral economics, Charness and Rabin (2002) and Engelmann and Strobel (2004) suggest some models of social preferences, social-efficiency and maximin preferences. Considering ISD as a simple distribution experiment among non-overlapping generations, these models suggest that a generation is likely to choose option B, when more members possess preferences for prosociality, social-efficiency, maximin and/or a combination of these preferences. All of these predictions are qualitatively valid when we reasonably assume that deliberation induces a generation to decide between options A and B, reflecting the preferences of the majority in a generation.

Our hypothesis in this experiment is that intragenerational deliberation induces individual opinions and collective decisions to support intergenerational sustainability in ISD (Brandon et al., 2019, Hauge et al., 2019). Theory of deliberative process establishes that deliberation can bring a change in individual opinions and resolve important problems in collective decision environments (see, e.g., Simon and Sulkin, 2002, Goeree and Yariv, 2011, Ban et al., 2012, List et al., 2013). Given this state of affairs, this research is considered to provide an experimental and analytical framework to explore how intragenerational deliberation induces a change in individual opinions, leading generations to resolve ISD. However, the patterns of such changes in individual opinions

settings (Bolton and Zwick, 1995, Laury et al., 1995, Roth, 1995).

may depend on the types of societies due to a difference of human nature, economic environment and characteristics between rural and urban areas, leading to a distinct outcome of generation decisions in ISDG (Cason and Mui, 1998, Engel, 2011, Fehr and Leibbrandt, 2011, Crawford and Harris, 2018). Specifically, this paper seeks to explore the following open questions: (i) Does intragenerational deliberation change individual opinions of rural and urban subjects for an intergenerational problem such as ISD in a different manner? (ii) Do such changes in individual opinions induce generations to resolve ISD in each society?

3 Results

Summary statistics about subjects' sociodemographic and psychological variables collected through questionnaire surveys are presented in table 1. In rural areas, $44\,\%$ of the subjects are male, while, in urban areas, $66\,\%$ of them are male. This fact reflects that a considerable portion of household heads are working away from home in rural areas (Massey et al., 2010). With respect to education, subjects in rural areas only possess 10 years of schooling on an average, whereas more than $50\,\%$ of the subjects in urban areas have an undergraduate degree with 16 years of schooling. With respect to employment, $88\,\%$ of the rural subjects engage in farming and forestry as their main activities, whereas only $37\,\%$ of urban subjects do so. The household income is lower in rural areas than in urban areas, and the percentages of a single family structure in rural and urban areas are, respectively, $47\,\%$ and $62\,\%$. The average family size does not differ between urban and rural areas. The critical thinking disposition is slightly lower in rural areas than in urban areas. With respect to social value orientation, $62\,\%$ and $47\,\%$ of subjects are prosocial in rural and urban areas, respectively. Overall, the summary statistics regarding the sociodemographic and psychological variables presented in table 1 suggest that there are some differences between these two areas.

[Table 1 about here.]

[Table 2 about here.]

Generation choices for the intergenerational unsustainable option A and sustainable option B in ISDG are presented in table 2. It indicates that from a total of 121 generations (62 and 59 generations are in rural and urban areas, respectively), 90 ($74.38\,\%$) generations choose sustainable option B and 31 ($25.62\,\%$) generations choose unsustainable option A. Furthermore, in rural areas, from 62 generations, 52 ($83.87\,\%$) generations choose option B and 10 ($16.13\,\%$) generations choose option A. In urban areas, from 59 generations, 38 ($64.41\,\%$) generations choose option B and 21 ($35.59\,\%$) generations choose option A. We perform a chi-squared test with the null hypothesis that the distributions over generation choices between options A and B across the two areas are the same. The result rejects the null hypothesis at a statistical significance of $5\,\%$ ($\chi^2 = 6.01, p = 0.014$). In summary, generations in urban areas more often choose the intergenerational unsustainable option A than generations in rural areas.

[Table 3 about here.]

The frequency and percentage of generation choices between options A and B with respect to the number of prosocial members in each generation are presented in table 3. In both rural and urban areas, the choices of sustainable option B increase with the number of prosocial members in a generation. Another interesting fact is that a majority of generations choose B in rural areas when at least one subject in a generation is prosocial. In contrast, in urban areas, a majority of generations do not necessarily choose B even when one subject in a generation is prosocial. These facts illustrate that in addition to prosociality in a generation, there may be other factors, such as an area effect, that affect generation choices between unsustainable option A and sustainable option B. For this purpose, we perform a logistic regression to characterize a generation choice with respect to prosociality, areas and other independent variables. Table 5 presents the marginal effects of an independent variable on the probability for a generation to choose option B, taking the generation choice of option A as the base group for the dependent variable in the logistic regression. In model 1, we include an area dummy and the number of prosocial members in each

generation as independent variables. To check the robustness of the result in model 1, we add other sociodemographic and psychological variables such as gender, education, monthly income, single family type, critical thinking disposition, agricultural involvement, the previous generations' decision and the percentage of choosing option B in sequence history at a generational level in model 2 (see table 4 for the definitions).

[Table 4 about here.]

Model 1 in table 5 shows that the area dummy and a number of prosocial subjects in a generation are economically and statistically significant, demonstrating that generations in rural areas have a $14.2\,\%$ greater probability of choosing sustainable option B compared with generations in urban areas. Furthermore, an increase in a number of prosocial members per generation leads to a $21.5\,\%$ increase in the probability of choosing B. These two findings are statistically significant at the $5\,\%$ and $1\,\%$ levels, respectively. In model 2 of table 5, gender, education, monthly income, single family type, critical thinking disposition, agricultural involvement, the previous generations' decision and the percentage of choosing option B in sequence history as explanatory variables have no effect on generation choices.[12] Overall, the analysis suggests that the number of prosocial members per generation and the area dummy are consistently significant and robust, irrespective of the regression specifications and they are important determinants for generation decisions.

[Table 5 about here.]

Table 6 presents the frequency and percentage of "individual initial opinion" to have supported A, B or to have been ambivalent (or no ideas) as N before deliberation and the "individual final opinion" after deliberation. When there are no individual opinion changes from initial to final

[12]To check the robustness for the main result in table 5, we run additional models of logit regression. We consider (i) the previous generations' choices within a sequence history and (ii) some sociodemographic variables at the generational level as independent variables, building upon the base model 1. Table 5 presents the marginal effects of the independent variables, confirming that the percentage of choosing option B by previous generations within a sequence history as well as the sociodemographic variables are not significant in model 2. We have also tried some interaction terms between area dummy and the percentage of choosing option B in history (sociodemographic variables), however, none of them are significant. We have consistently found the same tendency that the number of prosocial members and the area dummy remain significant $1\,\%$ and $10\,\%$ level.

opinions, such situations are coded as AA, BB or NN, where the first (second) letter represents the individual opinions before (after) deliberation. The other combinations of the two letters represent a situation in which a subject changes her individual opinions over a course of deliberation. For instance, AB describes a situation in which the subject initially had her initial opinion to support A before deliberation, but changed her final opinion to support B after deliberation. Subjects who do not change their opinions to support sustainable option B (i.e., subjects with BB) account for $78.49\,\%$ and $55.93\,\%$ in rural and urban areas, respectively (See table 6). Subjects who do not change their opinions to support unsustainable option A (i.e., subjects with AA) account for $9.14\,\%$ and $16.95\,\%$ in rural and urban areas, respectively. This result implies that a majority of subjects in rural areas have a consistent opinion of BB, whereas approximately half of subjects in urban areas exhibit variation in their opinions other than BB through deliberation.[13]

Table 6 also shows that individual opinion changes occur much more often in urban areas than in rural areas. These results are in line with the fact that more prosocial subjects are found in rural areas than in urban areas (see table 1). In fact, we identify that a majority of rural subjects are prosocial, expressing their opinions to support BB in their interviews. To identify the variation in initial and final opinions, we apply the coefficient of "unalikeability" as a concept of variability for an unordered categorical variable (Gordon, 1986, Kader and Perry, 2007, Frankfort-Nachmias and Leon-Guerrero, 2017).[14] We have identified that the coefficients of "unalikeability" in initial (final) opinions are 0.24 (0.32) and 0.46 (0.52) for rural and urban areas, respectively, confirming that urban subjects have a wider variety of initial and final opinions than rural subjects.

[Table 6 about here.]

The previous literature has suggested that deliberation leads to collective decisions with unanimity (Gerardi and Yariv, 2007, Neilson and Winter, 2008, Gillet et al., 2009, Ruth and Danziger,

[13]Subjects changing their opinions from A (N) to B, as AB (NB). $1.08\,\%$ $(2.15\,\%)$ and $6.78\,\%$ $(1.13\,\%)$ of subjects are classified as AB (NB) in rural and urban areas, respectively. These percentages are not necessarily high compared with those of other opinion shifts, such as BA or BN. For instance, $2.15\,\%$ $(5.38\,\%)$ and $6.21\,\%$ $(5.08\,\%)$ of subjects are classified as BA (BN) in rural and urban areas, respectively.

[14]The coefficient of "unalikeability" measures how often observations differ from one another within a same treatment group, and it is measured on a scale from 0 to 1 and higher the value is, the more unalike or variable the data are.

2016). With the data regarding individual opinion changes, we examine whether the aforementioned claim is true in ISDG. To this end, we introduce some terminologies to classify various cases of unanimity that can arise in ISDG. When all members in a generation have the same "individual initial opinion" of A, B or N before the deliberation, we call such a generation as a generation with "unanimity before deliberation;" otherwise, it is called a generation with "nonunanimity before deliberation." Similarly, when all the members in a generation have the same "individual final opinion" of A, B or N, it is called a generation with "unanimity after deliberation;" otherwise, it is called a generation with "nonunanimity after deliberation." With these definitions, all the generations fall into one of the following unanimity categories: 1. Unanimity and 2. Nonunanimity before and after deliberation.

Table 7 presents that, out of a total of 121 generations, 91 generations (39 and 52 in urban and rural areas) have unanimity before deliberation but only 75 generations (32 and 43 in urban and rural areas) are identified to have unanimity after deliberation. Thus, the number of generations that reached unanimity decline from 91 to 75 through deliberation. Furthermore, to statistically establish our result, we run a chi-squared test with the null hypothesis that the distributions of generations that reach unanimity before and after deliberations are the same. The result rejects the null hypothesis at $5\,\%$ significance level ($\chi^2 = 4.73, p = 0.029$), implying that deliberation in ISDG does not necessarily induce generations to reach unanimity. The previous literature has suggested that "deliberation leads to collective decisions with unanimity" (Gerardi and Yariv, 2007, Neilson and Winter, 2008, Gillet et al., 2009, Ruth and Danziger, 2016). However, in ISDG, such a claim is unlikely to be true.

[Table 7 about here.]

Next, we statistically analyze the factors that cause individual opinion changes through deliberation. For identifying such factors, we run logit regression taking an individual opinion change through deliberation as a dependent variable. The dependent variable is a dummy variable that takes a value of 1 when a subject changes her opinion to support A, B or N before and after deliberation, such as AB, AN, BA, BN, NA and NB. The independent variables include the area

dummy, critical thinking disposition, preunanimity, minority dummy, social value orientation and sociodemographic factors such as gender, age, education, monthly income, family size and agricultural involvement. The definitions of all the variables are summarized as "variables at individual level" in table 4. Table 8 presents the marginal effects of an independent variable on the probability for a subject to have an opinion change in models 1 and 2. In model 1, we do not control for sociodemographic variables, while we include sociodemographic variables in model 2 for a robustness check.

The area dummy, critical thinking disposition and preunanimity dummy have a negative effect on an individual opinion change, while the minority dummy has a positive effect on opinion changes through the deliberation in both models 1 and 2. On the other hand, the sociodemographic variables in model 2 do not exhibit any effect.[15] The area dummy is statistically significant in that rural subjects are $10.1\,\%$ less likely to change their opinions through the deliberation, compared to urban subjects. This rural-area effect is considered strong because a high portion of rural subjects ($78.49\,\%$) consistently chose sustainable option B (See table 6). In summary, it appears that there are less variation in individual opinions and less chances in opinion changes among rural people, because they usually have homogeneous culture and ways of thinking that come from similar social learning and experiences from generation to generation through social interactions (Hooper et al., 2015, Schniter et al., 2015).

[Table 8 about here.]

The results in model 1 show that a critical thinking and unanimity before deliberation are negatively associated for a member of a generation to change his/her opinions through deliberation.[16] However, the magnitude of the effect of critical thinking on opinion changes could be considered rather small. Subjects with higher critical thinking abilities should be able to judge and understand the quality of arguments with a logical validity in deliberation. Therefore, they are less likely to

[15] We have also tried different specifications of regressions in addition to models 1 and 2, but the qualitatively identical results have been obtained.

[16] One-unit-scale increase in critical thinking disposition leads to a decrease of $1\,\%$ in the probability for a member of a generation to change his/her opinions through deliberation at $1\,\%$ significance level.

change their opinion, being qualitatively consistent with previous researches (Nakagawa, 2015, Howarth et al., 2016). Furthermore, when generations have unanimity before deliberation (or preunanimity in the regression), the probability for their members to change their opinions decreases by $10.1\,\%$ at $5\,\%$ significance level, compared with generations without the unanimity. Overall, whether or not members in a generation have the same opinion, i.e., "unanimity before deliberation," is identified to be a key factor for determining whether subjects in the generation change their opinions. Finally, the results also demonstrate that a subject with a minority of her initial opinion in a generation is $16.2\,\%$ more likely to change her opinion, compared with non-minority subjects, at $1\,\%$ significance level. In summary, we have identified that area dummy, critical thinking disposition, preunanimity dummy and minority dummy are identified to be the major factors related to individual opinion changes.

The experimental results demonstrate that rural subjects choose sustainable option B more often than do urban subjects and the number of prosocial members per generation is a key factor. Next, urban subjects are identified to have a wider variety of individual initial opinions than rural subjects, and the individual opinions change through deliberation when subjects in a generation do not share the same initial opinion, reflecting that urban subjects change opinions as compared with rural ones. Consequently, urban (subjects) generations (support) choose an unsustainable option more often than do rural ones. Overall, tables 6 to 8 illustrate that intragenerational deliberation is not successful at inducing individuals and generations to support and choose sustainable opinion B, respectively. Now, with these results, we can answer the two open questions posed at the end of introduction section and section 2.3: (i) Does intragenerational deliberation change individual opinions of rural and urban subjects for an intergenerational problem such as ISD in a different manner? Our answer to the question is that urban subjects change their opinions more often than do rural subjects through intragenerational deliberation, and (ii) Do such changes in individual opinions induce generations to resolve ISD in each society? Our answer to the question is that the individual opinion changes that mainly occur in urban areas do not work in the direction to enhance intergenerational sustainability. In summary, our results suggest that intragenerational deliberation

is not effective at resolving intergenerational sustainability.

4 Discussion and conclusion

This research has examined how intragenerational deliberation changes individual opinions and can be a resolution for intergenerational sustainability dilemma (ISD) in societies by conducting the framed field experiment in two Nepalese contexts (urban and rural areas). Our results demonstrate that the majority of the generations in both societies support a sustainable option B and the findings are different from Shahrier et al. (2017) where the majority have chosen option A in an urban city, Dhaka. The possible explanation is that life in Dhaka is much more competitive to live than in Kathmandu and a majority of urban Bangladeshi people are found to be proself, reflecting the fact that Dhaka is the world's most densely populated city (Shahrier et al., 2016, Bangladesh Bureau of Statistics, 2017). Cason and Mui (1997) claim that intragroup face-to-face communication does not always lead groups to make rational and self-regarding decisions, following standard economic theory. However, some studies have found that group behaviors can be more self-regarding and rational than individual behaviors in the same settings (Dawes et al., 1977, Isaac and Walker, 1988, Bornstein and Ben-Yossef, 1994, Kugler et al., 2012, Charness and Sutter, 2012, Cooper and Kuhn, 2016, Meub and Proeger, 2017, Crawford and Harris, 2018, Carbone et al., 2019, Vollstadt and Bohm, 2019). This study shows that how intragenerational deliberation affects intergeneration behaviors shall be depending on socioeconomic contexts, cultures and norms in people's daily life (Henrich et al., 2005, 2010b, Fehr and Leibbrandt, 2011).

Urban subjects have a wider variety of individual initial opinions and support unsustainable options more often than do rural subjects. This result can be compared with the findings of Cason and Mui (1998), Luhan et al. (2009) and Crawford and Harris (2018) showing that social interaction influences group decisions in the way that self-regarding individuals are influential. Our findings show that individual opinions change through deliberation when subjects in a generation do not share the same initial opinion, reflecting that more urban subjects change opinions.

However, we identify that such changes do not necessarily work in the direction to enhance intergenerational sustainability, because some people in the group might have strong self-regarding preferences influencing generation decisions. Fischbacher et al. (2001), Chaudhuri (2011) and Hauser et al. (2014) show that cooperation among group members increases when they are aware of the presence of conditional cooperators. Given these findings, one way to interpret our result is that urban generations are likely to identify at least one self-regarding member, but less likely to spot (conditional) cooperators through intragenerational deliberation, choosing an unsustainable option.

A novelty of our experimental design as compared with Kamijo et al. (2017) and Shahrier et al. (2017) is conducting interviews to identify individual opinion changes over the course of deliberation. The interviews reveal that there is a fundamental difference in terms of how deliberation affects individual opinions between rural and urban areas in ISDG. In rural areas, approximately $80\,\%$ of subjects consistently support sustainable option B without any opinion change during deliberation, whereas about half of the urban subjects change their opinions. Gachter and Thoni (2005) find that cooperation among like mindset people in a group tends to be higher and more stable than that among different mindset people in a group. Being consistent with the result in Gachter and Thoni (2005), we find that urban generations consist of people with a wider variety of individual initial opinions, changing their individual opinions and choosing an unsustainable option more often than rural ones. It can be interpreted that urban subjects with a variety of opinions face conflicts of interest during intragenerational deliberation and, thus, the deliberation takes long as compared to rural subjects. As a result, deliberation does not successfully induce urban subjects and generations to support sustainable option B.

This study demonstrates that people's social preferences such as prosociality are key factors to characterize intergenerational sustainability. Prosocial preferences directly affect people's decisions about how to live, such as unplugging cell phones, using public transport to commute work and/or installing a solar panel on a roof for energy (Van Lange et al., 2007). The higher proportion of prosocial people are found in rural areas than in urban ones, and there are significant differences

between these areas in terms of their environment, uses of technologies and social interactions among people. In many cases, basic city life in urban areas such as Kathmandu and Pokhara does not require people to have human interactions or intimacy even with their colleagues. In contrast, people in rural areas have close interactions and intimacy with their neighbors owing to their direct dependency on ecology and agriculture-based activities, and a closely-knit rural society such as rural areas in Nepal can be considered a hope for resolving ISD. With these realities, we believe that the difference in how people interact with others affects social preferences and behaviors (Charness and Rabin, 2002, Engelmann and Strobel, 2004, Shahrier et al., 2017). Therefore, practices of shared values through education and social interactions shall be one possible approach to enhance intergeneration sustainability through creating a close-knit society such as permaculture movement in some parts of the world (Akhtar et al., 2016, Maye, 2016, Ulbrich and Pahl-Wostl, 2019).

Literature has suggested that deliberation leads to fair collective decisions in some class of intragenerational problems, particularly when they have an chance to reach Pareto improvement (Cardenas, 2000, Cardenas et al., 2000, Blume and Ortmann, 2007, Gerardi and Yariv, 2007, Neilson and Winter, 2008, Gillet et al., 2009, Cason et al., 2012, Ghate et al., 2013, Ruth and Danziger, 2016). In this research, it is demonstrated that intragenerational deliberation is not effective at assuring intergenerational sustainability in ISDG where there is no room for Pareto improvement. Fochmann et al. (2018) observe that subjects are more concerned about fairness in intragenerational distributional problems than in intergenerational ones. With the result, it is so intuitive that intragenerational deliberation cannot resolve intergenerational problems such as ISD. In reality, people in contemporary societies have failed in resolving some important intergenerational problems, such as climate change, through intragenerational deliberation over time. Therefore, our results imply that some new social mechanisms in addition to or other than intragenerational deliberation must be designed and instituted if we really want to resolve intergenerational sustainability problems.

We note some limitations of the study and directions for future research. First, our experiment is instituted under nonoverlapping generations to focus only on the ISD problems. In reality, how-

ever, generations are overlapping in societies. Future research should be able to be reorganized for addressing ISD with overlapping generations. Second, although we find that deliberation does not resolve ISD, future research may be able to find a new type of social mechanisms, potentially with deliberative processes, for resolving ISD. Finally, this research does not fully utilize the contents of generations' discussions for analyzing why individual opinion changes occur in deliberation along with generation decisions. Future research should be able to characterize the detailed dynamic processes for individual opinion changes and generation decisions via qualitative deliberative analysis of discussion contents, as is done in psychology and political science (Brinkmann, 2014).

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List of Figures

Figure 1: Study regions: Urban and rural areas of Nepal

Figure 2: Instructions for the "slider method" to measuring social value orientation

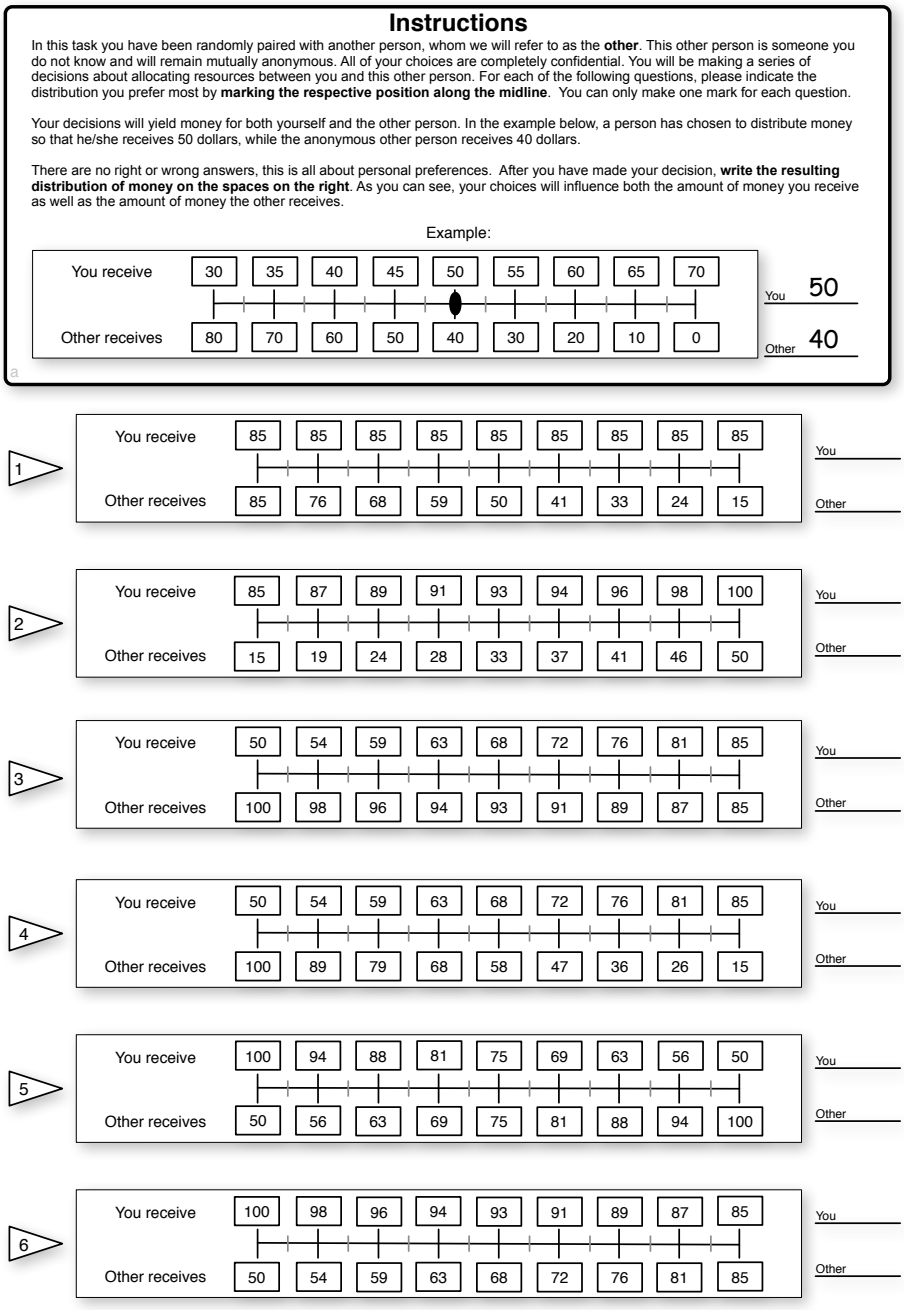
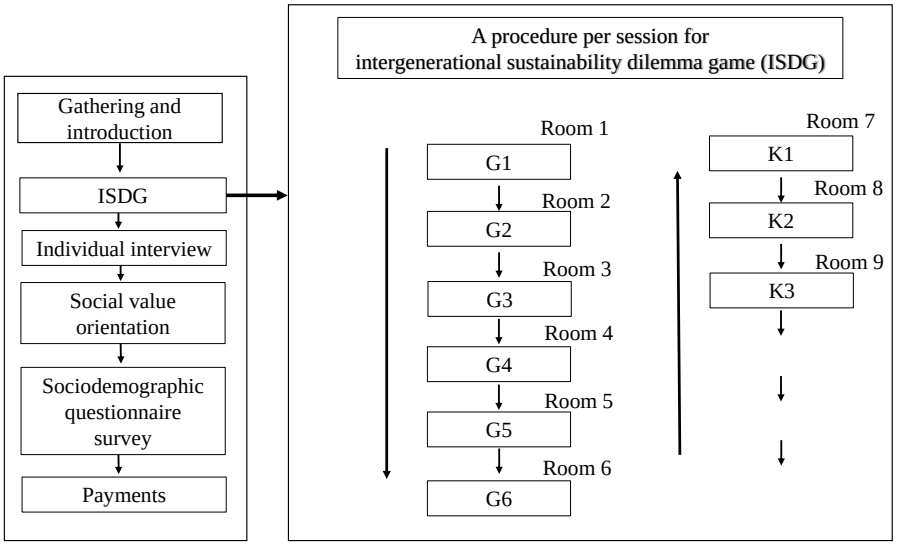


Figure 3: A flow chart of procedure for the ISDG experiment and questionnaire survey per session. In the ISDG experiment, each room has two-digit ID with one letter of alphabets and a number, such as G1 or K1. The alphabet letter represents a sequence ID, while the number does the generation ID within the sequence



List of Tables

Table 1: Summary statistics

Variables	Urban (59 generations, 177 subjects)					Rural (62 generations,186 subjects)				
	Mean	SD[1]	Median	Min	Max	Mean	SD	Median	Min	Max
Age[2]	33.77	11.38	32.50	18.00	56.00	33.27	11.54	30.5	16.00	66.00
Gender[3]	0.66	0.47	0.00	0.00	1.00	0.44	0.50	0.00	0.00	1.00
Education[4]	15.20	3.42	16.00	5.00	18.00	10.18	2.86	10.00	1.00	18.00
Agricultural involvement[5]	0.37	0.50	1.00	0.00	1.00	0.88	0.33	1.00	0.00	1.00
Monthly income (in NPR 10,000)[6]	5.10	8.05	3.40	1.00	90.00	0.31	4.05	1.50	0.50	30.00
Single family[7]	0.62	0.48	1.00	0.00	1.00	0.47	0.51	0.00	0.00	1.00
Family size[8]	3.03	0.94	3.00	1.00	5.00	3.15	1.13	3.00	1.00	5.00
Cognitive & psychological variables										
Critical thinking disposition[9]	48.14	7.12	49.00	23.00	65.00	47.62	6.45	48.00	25.00	65.00
SVO[10]	0.47	0.50	1.00	0.00	1.00	0.62	0.48	1.00	0.00	1.00

[1] "SD" stands for standard deviation.
[2] Age is a continuous variable given in years.
[3] A dummy variable that takes the value 1 when the subject is male and 0 otherwise .
[4] Education represents years of schooling.
[5] Agricultural involvement is a dummy variable that takes the value 1 when a subject is stably employed or engaged in the agricultural sector and 0 otherwise.
[6] Monthly income is given in Nepalese rupees (NPR).
[7] Single family is a dummy variable that takes the value of 1 if the participant is in a single family structure and 0 otherwise.
[8] Family size is the number of family members.
[9] Critical thinking disposition is the summation of rates from 1 to 5 over 13 items, and the theoretical range is 13-65. In each item, a question is posed, and a subject is asked to choose among 1 "strongly disagree," 2 "disagree," 3 "neutral," 4 "agree" and 5 "strongly agree."
[10] "SVO" is a dummy variable that takes a value of 1 when a subject is prosocial and 0 otherwise.

Table 2: The frequency and percentage of generation choices between options A and B (percentage in parenthesis)

Generation choices between options A and B	Area		Total
	Urban	Rural	
A	21 (35.59 %)	10 (16.13 %)	31 (25.62 %)
B	38 (64.41 %)	52 (83.87 %)	90 (74.38 %)
Total	59 (100.00 %)	62 (100.00 %)	121 (100.00 %)

Table 3: The frequency and percentage of generation choices between options A and B with respect to the number of prosocial members in each generation

# of prosocial members per generation	Urban		Rural	
	A	B	A	B
0	5 (8.48 %)	3 (5.10 %)	7 (11.29 %)	0 (0.00 %)
1	10 (16.95 %)	10 (16.95 %)	3 (4.84 %)	10 (16.13 %)
2	6 (10.17 %)	23 (40.00 %)	0 (0.00 %)	25 (40.32 %)
3	0 (0.00 %)	2 (3.39 %)	0 (0.00 %)	17 (27.42 %)
Subtotal	21 (35.59 %)	38 (64.41 %)	10 (16.13 %)	52 (83.87 %)
Total	59 (100 %)		62 (100 %)	

Table 4: Definitions of the variables included in the regressions

Variables	Definitions of variables included in regressions
Variables at generation level	
Generation choices between options A and B	A dummy variable that takes 1 if the generation choose option B, otherwise 0.
# of prosocial members in a generation	A number of prosocial members in each generation.
Area dummy	A dummy variable that takes 1 if the generation is from the rural area, otherwise 0.
Gender	A variable that represents the number of males in each generation.
Education	A variable that represents average years of schooling over three subjects in each generation.
Monthly income	A variable that represents an average household income of three subjects in each generation.
Single family	A variable that represents a number of members in a generation that have a single family structure.
Agricultural involvement	A variable that represents a number of members in a generation who engage in agriculture.
Previous generation decision	A dummy variable that takes 1 if the previous generation chooses option B, otherwise 0.
Percentage of choosing option B in sequence history	A variable that represents the percentage of previous generations that chose option B in a sequence.
Variables at individual level	
Individual opinion change	A dummy variable that takes 1 when a subject changes her individual opinion to support A, B or N before and after deliberation or over a course of deliberation.
Critical thinking disposition	A variable that represents the summation of rates from 1 to 5 over 13 items of questions. each subject answers in her questionnaire and the theoretical range is 13-65
Preunanimity	A dummy variable that takes 1 when the subject belongs to the generation in which all members supported the same option before deliberation, otherwise 0.
Minority	A dummy variable that takes 1 when the subject have a different opinion from other two members in a generation, otherwise 0.
SVO	A dummy variable that takes 1 when the subject is identified as prosocial, otherwise 0.
Gender	A dummy variable that takes 1 when the subject is male, otherwise 0.
Agricultural involvement	A dummy variable that takes 1 when the subject engages in agriculture sector otherwise 0.
Education	A variable that represents the subject's years of schooling.
Single family	A dummy variable that takes 1 if the subject has a single family, otherwise 0.
Monthly income	A variable that represents monthly household income.

Table 5: Marginal effects of independent variables in the logit regression for generation choices between options A and B where the dependent variable of generation choices takes the value 1 with option B, otherwise 0.

Variables	Model 1	Model 2
Area dummy (Urban areas $= 0$)	0.142**	0.192*
	(0.065)	(0.110)
# of prosocial members in a generation	0.215***	0.211***
	(0.033)	(0.034)
Gender		-0.010
		(0.047)
Education		0.016
		(0.016)
Monthly income		-0.000
		(0.000)
Single family		0.014
		(0.040)
Critical thinking disposition		(-0.006)
		(0.010)
Agricultural involvement		-0.009
		(0.042)
Previous generation's decision		-0.010
		(0.084)
Percentage of choosing option B in sequence history		-0.030
		(0.090)
Sample size	121	102

***significant at $1\,\%$ level, **significant at $5\,\%$ level and *significant at $10\,\%$ level.
The Wald χ^2 statistics are 41.47 and 34.44 in models 1 and 2, respectively.

Table 6: The frequency and percentage of change in individual opinions for supporting option "A," "B," or "N" ambivalent/no ideas before and after the deliberation (percentage in parenthesis)

Individual opinion change	Areas	
	Urban	Rural
AA	30 (16.95 %)	17 (9.14 %)
AB	12 (6.78 %)	2 (1.08 %)
AN	9 (5.08 %)	2 (1.08 %)
BB	99 (55.93 %)	146 (78.49 %)
BA	11 (6.21 %)	4 (2.15 %)
BN	9 (5.08 %)	10 (5.38 %)
NN	2 (1.13 %)	0 (0.00 %)
NA	3 (1.69 %)	1 (0.54 %)
NB	2 (1.13 %)	4 (2.15 %)
Total	177 (100.00 %)	186 (100.00 %)

Table 7: The number of generations with unanimity before and after the deliberation

Deliberation	Unanimity	Non-unanimity	Total
Before	91	30	121
After	75	46	121

39 generation out of 59 generation have unanimity before deliberation in urban, whereas 52 out of 62 generation in rural areas.

Table 8: Models 1 and 2: Marginal effects of independent variables in the logit regression for individual opinion change

Variables	Model 1	Model 2
Area dummy (Urban areas $= 0$)	-0.101**	-0.108*
	(0.040)	(0.060)
Critical thinking disposition	-0.010***	-0.010***
	(0.003)	(0.003)
Preunanimity	-0.101**	-0.105**
	(0.045)	(0.049)
Minority	0.162***	0.141**
	(0.060)	(0.065)
Including other socio-demographic variables in model 2		
SVO dummy (Proself $= 0$)		-0.020
		(-0.042)
Gender (Base group $=$ female)		0.063
		(0.046)
Age		-0.001
		(-0.002)
Education (Years of schooling)		-0.010
		(0.007)
Monthly income		0.000
		(0.000)
Family size		-0.014
		(0.021)
Agricultural involvement		0.015
		(0.051)
Sample size	363	331

***significant at $1\,\%$ level; **significant at $5\,\%$ level; *significant at $10\,\%$ level.
The Wald χ^2 statistics are 43.06 and 42.28 in models 1 and 2, respectively, and they are significant at $1\,\%$ level.